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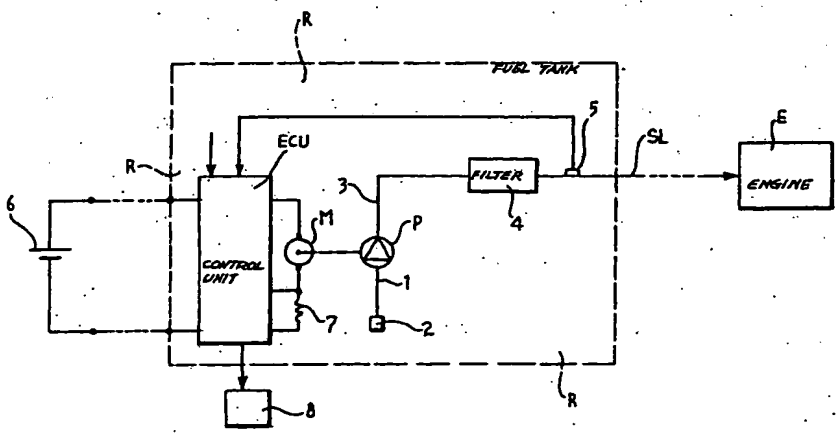
(54) A controlled-pressure fuel-supply system for an internal combustion engine, particularly for motor vehicles

(57) The system comprises

a hydraulic pump (P) driven by an electric motor (M),
a pressure sensor (5) associated with the pump (P) for supplying an electrical signal indicative of the pressure of the fuel at the output or delivery (3) of the pump (P), and a control unit (ECU), associated with the electric motor (M) of the pump (P) and connected to the pressure sensor (5), for varying the operating point of the electric motor (M) in dependence on the fuel pressure indicated by the sensor (5) so as to keep the pressure at a substantially constant value.

FIG. 1



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Description

[0001] The present invention relates to a controlled-pressure fuel-supply system for an internal combustion engine, particularly but not exclusively for motor vehicles.

[0002] More specifically, the subject of the invention is a controlled-pressure fuel-supply system comprising a positive-displacement pump driven by an electric motor.

[0003] The object of the present invention is to provide an improved fuel-supply system which can achieve energy savings and can implement safety measures in certain operating conditions.

[0004] This and other objects are achieved, according to the invention, by the fuel-supply system the principal characteristics of which are defined in appended Claim 1.

[0005] Further characteristics and advantages of the invention will become clear from the following detailed description, provided purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a schematic view of a fuel-supply system according to the invention, and

Figure 2 is a side view of an embodiment of the system.

[0006] In Figure 1, the fuel tank of an automotive vehicle such as a motor vehicle is generally indicated R. The tank is connected to the internal combustion engine E of the motor vehicle by a supply pipe SL.

[0007] A pipe, not shown in the drawing, may also be provided between the engine E and the tank R, for returning fuel to the tank.

[0008] In the tank R there is a hydraulic pump P of known type, rotated by an associated electric motor M.

[0009] The pump P has an intake or inlet duct 1 which is associated with an (optional) filter 2, for example, of the so-called "sock" type, for the drawing of fuel from the tank.

[0010] The pump P also has an outlet or delivery duct 3 which is connected to the supply pipe SL via a main filter 4. This filter can also be advantageously disposed inside the tank.

[0011] An electronic pressure sensor 5 associated with the output of the filter 4 is connected to an input of an electronic control unit ECU. This unit is connected to the electric motor M associated with the pump P and is arranged to control the motor in dependence on the signals supplied by the pressure sensor 5 in operation.

[0012] As shown schematically in Figure 1, the pressure sensor and the control unit ECU are also advantageously housed in the tank R.

[0013] The control unit ECU can be connected to a direct-current voltage supply 6 such as a motor-vehicle battery and is arranged to control the voltage applied to the motor M and/or the current caused to flow in the motor.

[0014] In particular, the control unit ECU is arranged to control the motor M in a manner such that the fuel pressure at the output of the filter 4 is kept substantially constant and equal to a predetermined value.

[0015] In operation, if the fuel pressure detected by the sensor 5 varies, the unit ECU varies the voltage applied to the motor M and/or the current flowing therein so as to keep the fuel pressure at the output of the filter 4 at the predetermined delivery value.

[0016] Thus, when the internal combustion engine E requires a greater flow-rate of fuel in operation, the sensor 5 detects a corresponding reduction in the fuel pressure at the output of the filter 4 and the unit ECU brings about an increase in the rate of rotation of the motor M and hence in the flow-rate of fuel supplied to the engine E, until the pressure detected by the sensor 5 corresponds to the predetermined delivery value.

[0017] If, in operation, there is an appreciable leak or even a break in the supply line SL which brings the fuel to the engine E, the control unit ECU can detect this condition on the basis of an analysis of the signal supplied by the pressure sensor 5. In fact, in the event of an appreciable leakage or of a breakage in the supply line SL, the pressure detected by the sensor 5 falls abruptly. In this situation, if the pump 5 is a one-way pump, the control unit ECU may advantageously be arranged to stop the pump. If, however, the pump P is a two-way pump, the control unit ECU may be arranged to reverse the sense of rotation of the motor M and hence of the pump P so that the fuel disposed between the output or delivery 3 of the pump P, the filter 4 and the point of the break or leak in the supply line SL is drawn back into the tank.

[0018] This reduces the danger of fire.

[0019] Sensor means may advantageously be associated with the motor M of the pump for detecting the current flowing through the motor. In the embodiment shown in Figure 1, these means comprise a shunt resistor 7 connected substantially in series with the motor. The terminals of the resistor 7 are connected to the control unit ECU so that this unit can deduce the actual intensity of the current flowing in the motor M from the value of the voltage developed at the terminals of the resistor. Moreover, the control unit ECU is advantageously arranged to implement one or more emergency functions when it detects that, in order to keep the fuel pressure at the delivery value, the motor M is absorbing a current of a magnitude greater than a predetermined maximum value. A situation of this type may occur, for example, when the supply line SL which brings the fuel to the engine E has a leak.

[0020] The unit ECU may then be arranged in a manner such that, upon the occurrence of a situation of this type, it stops or reverses the motor M and hence the pump P and/or activates a signal, for example, an opti-

cal or sound signal, by means of a corresponding indicator device, indicated 8 in Figure 1.

[0021] The control unit ECU can also be conveniently predisposed in a manner such as to cause a de-activation of the electric motor M as long as the pressure detected by the sensor 5 remains within a predetermined field of values ("normal" range), and to automatically reactivate the motor M as soon as said pressure falls below or (in the case of a bidirectional pump) rises above said field of values. This allows a considerable saving of electrical energy, which is particularly useful in motorcycles in which there is an almost relentless trend of increasing electric power consumption. The de-activation of the electric motor M when the fuel pressure lies within the normal range, and the subsequent reactivation of the same as soon as the detected pressure is out of said range, allow the management of the electric motor in a so-called "stop and go" manner, without requiring to that end any controls from the electronic management unit possibly associated with the combustion engine E.

[0022] When the motor M is de-activated and then re-activated in the above-described management mode, it is necessary to avoid that the motor be too heavily stressed due to the repeated re-startings thereof.

[0023] To that end, the control unit ECU is advantageously predisposed to control, at each re-start, the current supplied to the motor M in the start-up phase, by monitoring the intensity of said current through the shunt resistor 7.

[0024] Said shunt resistor (or other suitable current sensor) allows thus, in a sinergistic way, to detect emergency situations and carry out the corresponding operations or functions as described above, and to monitor and control in feedback the current supplied to the pump motor M in the start or re-start phases.

[0025] The system described above enables the supply of fuel to the engine E to be controlled in dependence solely on the fuel pressure at the output of the pump P and hence completely independently of any electronic unit for controlling the engine E so that the system can be used in conjunction with any internal combustion engine.

[0026] Figure 2 shows a particularly advantageous embodiment of the system according to the invention.

[0027] In this drawing, parts and elements already described have again been attributed the same alphanumeric reference symbols.

[0028] In the embodiment of Figure 2, the pump-motor unit P, M with the associated intake filter 2 and delivery filter 4 are fixed to a single support structure comprising basically a flange 10 which is intended to be fixed in an opening of the fuel tank so that the unit and the associated filters extend inside the tank.

[0029] Fixed to the face of the flange 10 which is intended to face towards the inside of the tank R is (at least) one circuit board 11 which carries the components of the control unit ECU as well as an optional shunt resistor 7 and to which the pressure sensor 5 and the supply terminals of the motor M associated with the pump P are also connected.

[0030] The circuit board 11 is connected to electrical supply terminals 12 and 13 which extend inside a connector 14 advantageously formed integrally with the flange 10 on the face of the flange facing towards the outside of the tank, for connection to the electrical system of the motor vehicle.

[0031] A level-measuring device 15 of known type for providing electrical signals indicative of the level of fuel in the tank R may advantageously but not necessarily be connected to the same flange 10. This device 15 may be resistive, inductive or capacitive or of other known types and has its own electrical terminals 16 housed in a connector 17 advantageously formed integrally with the flange 10.

[0032] The unit shown in Figure 2 is particularly advantageous since it can conveniently be pre-assembled and then mounted in the fuel tank in a single operation.

[0033] Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the invention as defined in the appended claims.

Claims

1. A controlled-pressure fuel-supply system for an internal combustion engine (E) particularly for motor vehicles, comprising a hydraulic pump (P) driven by an electric motor (M),
characterized in that it comprises, in combination,

   a pressure sensor (5) associated with the pump (P) for supplying an electric signal indicative of the hydraulic pressure of the fuel at the output or delivery (3) of the pump (P), and

   a control unit (ECU), associated with the electric motor (M) of the pump (P) and connected to the pressure sensor (5), for varying the operating point of the electric motor (M) in dependence on the fuel pressure indicated by the sensor (5) so as to keep the pressure at a substantially constant value.

2. A system according to Claim 1, in which the pump (P) is a two-way pump and the control unit (ECU) is arranged to reverse the sense of rotation of the motor (M) of the pump (P) when the difference between the pressure indicated by the sensor (5) and a predetermined pressure value is greater than a predetermined value.

3. A system according to Claim 1, in which the pump (P) is a one-way pump and the control unit (ECU) is arranged to stop the motor (M) of the pump (P) when the difference between the pressure indicated by the sensor (5) and a predetermined pressure value is greater than a predetermined value.

4. A system according to any one of the preceding claims, in which detector means (7) are associated with the motor (M) of the pump (P) for providing the control unit (ECU) with signals indicative of the current absorbed by the motor (M), and in which the control unit (ECU) is arranged to implement an emergency function when the current absorbed by the motor (M) exceeds a predetermined value.

5. A system according to Claim 4, in which the control unit (ECU) is arranged to stop the motor (M) of the pump (P) when the difference between the current absorbed by the motor (M) and a predetermined current exceeds a predetermined value.

6. A system according to claim 4 or Claim 5, in which the control unit (ECU) is arranged to produce a warning signal when the difference between the current absorbed by the motor (M) of the pump (P) and a predetermined current exceeds a predetermined value.

7. A system according to any of the preceding Claims, characterized in that the control unit (ECU) is predisposed to cause a de-activation of said electric motor (M) as long as the pressure detected by the sensor (5) lies within a predetermined field of values.

8. A system according to Claims 4 and 7, characterized in that the control unit (ECU) is predisposed to control in a predetermined manner the current supplied to said electric motor (M) every time the latter is started or re-started, as a function of the signals provided to said unit (ECU) by said current detector means (7).

9. A system according to any one of the preceding claims, in which the pressure sensor (5) and the control unit (ECU) are mounted on (at least) one circuit board or plate (11) fixed to a support structure (10) to which the pump (P) and the associated electric motor (M), as well as fuel-filtering means (2, 4) associated with the outlet or delivery duct (3) of the pump (P) and optionally with the inlet or intake duct (1) of the pump (P), are also connected, together forming a monolithic unit which can be fixed to a fuel tank (R).

10. A system according to Claim 9, in which an electric device (15) for measuring the level of fuel in the tank (R) is also connected to the support structure (10).

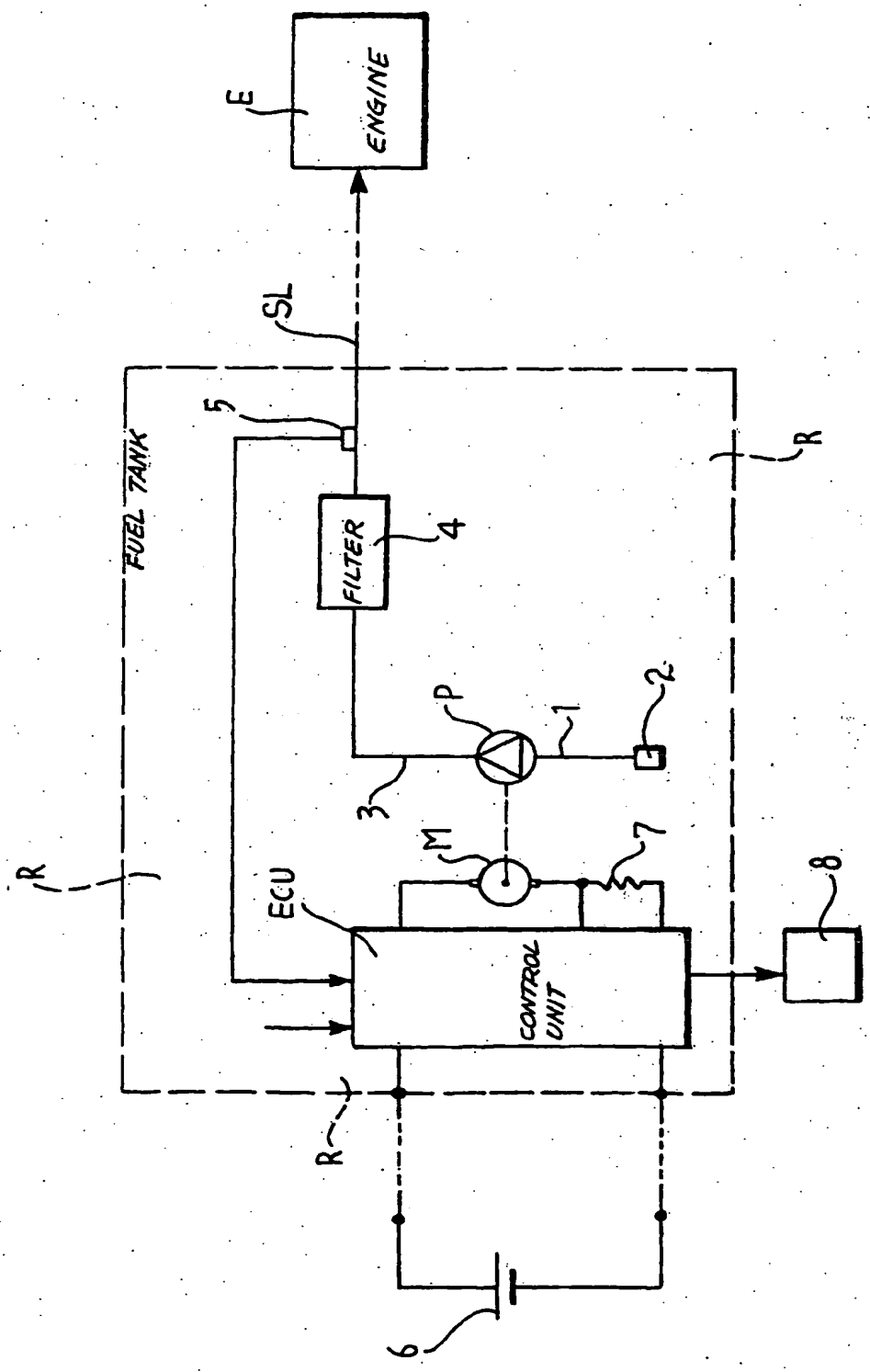
E
ENGINE
SL
5
FUEL TANK
R
FILTER
4
P
1
2
3
M
7
8
ECU
CONTROL UNIT
R
R
6

FIG. 1

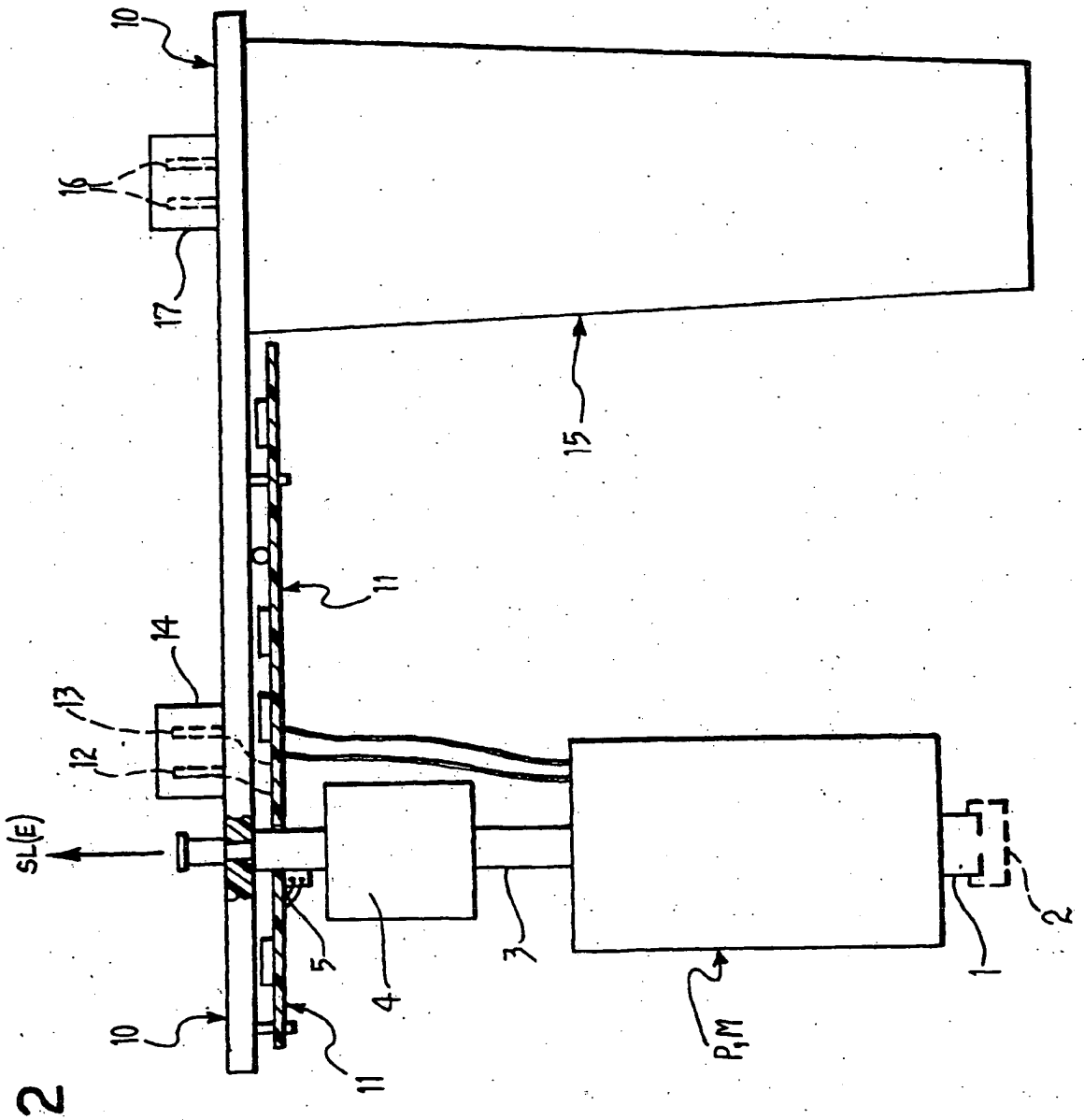

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 00 11 1525

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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F02D
F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 September 2000	Kooijman, F

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